Software Requirements Specification

for

Fire Extinguisher Robot

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1. Introduction

1.1 Purpose

The purpose of this report is to document the development and implementation of the Fire Extinguisher Robot project. It aims to provide a detailed account of the project's specifications, algorithms, and design features, and to showcase its potential as an advanced fire safety solution.Document

1.2 .Document Conventions

This report follows a standard document format, including sections such as introduction, problem specification, implementation details, results, conclusions, future scope, and references. It adheres to a clear and concise writing style, utilizing headings, subheadings, and bullet points for ease of reading and comprehension

1.3 . Intended Audience and Reading Suggestions

The intended audience for this report includes researchers, engineers, and individuals interested in robotics, fire safety, and emergency response systems. Prior knowledge of basic robotics concepts and programming is beneficial but not mandatory. For a comprehensive understanding, readers are encouraged to review the entire report, focusing on sections of interest and referring to specific subpoints as needed.

1.4 Product Scope

The Fire Extinguisher Robot is designed to detect and extinguish fires autonomously. It incorporates flame sensors, motors, a tank, an Arduino gas sensor, and an ESP32 camera. The camera module algorithm enables real-time monitoring and provides footage of fire incidents. The motor driver setup algorithm ensures precise movement control, while the algorithm for connecting the servo motor in the middle of three gas sensors optimizes fire detection capabilities.

1.5 References

1. Gao, X., Yao, Y., Qian, X., & Wu, J. (2018). IoT-based intelligent fire safety system for commercial buildings. IEEE Internet of Things Journal, 6(2), 2707-2716

2. Wang, C., Xu, L., & Cao, Y. (2019). Design of fire detection system based on IoT. In 2019 4th International Conference on Computer Science and Artificial Intelligence (CSAI) (pp.

253-257). IEEE.

3. Zhang, Y., Xue, Q., & Li, X. (2019). An IoT-based intelligent fire extinguishing robot for indoor firefighting applications. IEEE Access, 7, 157226-157236.
4. Martinez, J. A., Manso, L. J., & Garrido, A. J. (2020). Autonomous fire detection and extinguishing robot based on SLAM. Robotics, 9(1), 20

2. Overall Description

2.1 Product Perspective

2.2 The Fire Extinguisher Robot is a standalone system that operates independently. It incorporates various components such as flame sensors, motors, a tank, an Arduino gas sensor, and an ESP32 camera. The robot is designed to navigate different environments and effectively respond to fire incidents.

2.3 Product Functions

The primary function of the Fire Extinguisher Robot is to detect fires and suppress them. It achieves this by utilizing flame sensors to detect the presence of flames and gas sensors to monitor abnormal gas levels. The robot is equipped with motors for movement, a tank for water storage, and a submerged motor for water ejection. The ESP32 camera provides real-time footage for monitoring and analysis

2.4 User Classes and Characteristics

The Fire Extinguisher Robot is an innovative project designed to enhance firefighting capabilities. The primary user classes and their characteristics include firefighters, who are trained professionals with technical skills to control the robot during fire incidents. Emergency responders, such as paramedics and police officers, possess quick decision-making abilities and collaborate with the robot for efficient emergency response. Building owners and occupants rely on the robot's capabilities to minimize fire damage and ensure safety. Maintenance personnel ensure the robot's proper functioning through regular inspection and troubleshooting. Lastly, the general public appreciates the robot's contribution to public safety. With flame sensors, motors, tank, gas sensor, and an ESP32 camera, the robot utilizes algorithms for camera module setup, motor driver

configuration, and servo motor connection with gas sensors. The robot's design incorporates LED lights for enhanced visibility and features a submerged motor for water ejection, making it effective in extinguishing fires.

2.5 Operating Environment

The Fire Extinguisher Robot is designed to operate in various environments prone to fire incidents, such as buildings, warehouses, and industrial settings. It is capable of navigating through different surfaces, including smooth floors and uneven terrain.

2.6 Design and Implementation Constraints

The design of the Fire Extinguisher Robot is constrained by factors such as size, weight, and power consumption. The integration of various components, including the flame sensors, motors, tank, gas sensor, and camera, requires careful consideration to ensure compatibility and efficient operation.

2.7 User Documentation

Comprehensive user documentation will be provided to guide users in operating and maintaining the Fire Extinguisher Robot. The documentation will include setup instructions, operating procedures, troubleshooting guidelines, and safety precautions.

2.8 Assumptions and Dependencies

The Fire Extinguisher Robot operates under the assumption that the flame and gas sensors are accurate in detecting fire incidents and abnormal gas levels, respectively. It also assumes that the motor driver setup algorithm, camera module algorithm, and servo motor connection algorithm are properly implemented and functional. Dependencies include the availability of power supply, appropriate water source, and a stable communication network for the camera footage transmission.

3. External Interface Requirements

3.1 User Interfaces

The user interface of the Fire Extinguisher Robot should provide an intuitive and user-friendly interaction experience. It may consist of a control panel or a graphical user interface (GUI) on a display screen. The interface should allow users to initiate and control the robot's operations, adjust settings, monitor fire incidents, and receive feedback on the robot's status. Additionally, the user interface should support the control of motors and camera footage using a Bluetooth module.

3.2 Hardware Interfaces

The Fire Extinguisher Robot requires hardware interfaces to connect and communicate with its components. This includes establishing connections with the flame sensors, motors, tank, Arduino gas sensor, ESP32 camera, and the Bluetooth module for motor control. The interfaces should support the proper transfer of signals, power, and data between the robot and its hardware components.

3.3 Software Interfaces

The software interface encompasses the algorithms and software systems used in the Fire Extinguisher Robot. This includes the camera module algorithm for capturing and processing footage, the setup algorithm for motor control, and the algorithm for connecting the servo motor in the middle of the three gas sensors. The software interface should provide seamless integration and coordination between different software components, ensuring efficient operation and data flow.

3.4 Communications Interfaces

The Fire Extinguisher Robot requires a communication interface to transmit camera footage and receive control signals. The camera footage can be stored on a server, which can be accessed remotely for monitoring and analysis purposes. The communication interface may use Bluetooth technology for controlling the motors and transmitting data between the robot and external devices.

4. System Features

The Fire Extinguisher Robot is equipped with various features to effectively detect and extinguish fires. The main subpoints of the system feature include:

4.1 System Feature 1

4.1.1 Description and Priority

The description priority refers to the importance or criticality of each feature. It helps in determining the order of implementation and allocation of resources based on their significance to the overall functionality of the robot.

4.1.2 Stimulus/Response Sequences

The response sequence describes the expected behavior of the robot when a fire is detected. It includes the steps the robot takes to assess the situation, move towards the fire, activate the

water ejection system, and extinguish the fire. The response sequence should be designed to ensure the timely and efficient handling of fire incidents.

4.1.3 Functional Requirements

The functional requirements specify the specific capabilities and behaviors of the Fire Extinguisher Robot. These requirements include the integration and operation of the flame sensors, motors, tank, Arduino gas sensor, ESP32 camera, and the Bluetooth module for motor control. The camera module should be able to capture and process footage, and the algorithm for connecting the servo motor in the middle of three gas sensors should enable accurate gas detection and positioning. Additionally, the LED design elements should be incorporated into the system, including the large LED behind the camera and the red LED tape for visual appeal.

5. Other Nonfunctional Requirements

5.1 Performance Requirements

The Fire Extinguisher Robot should meet certain performance requirements to ensure efficient and effective operation. This includes the response time for fire detection and the speed at which the robot moves towards the fire. The robot should also be capable of extinguishing fires within a specified time frame. The performance requirements should be defined to ensure optimal performance and timely response.

5.2 Safety Requirements

Safety is a critical aspect of the Fire Extinguisher Robot project. The robot should be designed and programmed to operate in a safe manner, minimizing the risk of accidents or harm to users and the environment. Safety requirements may include implementing collision avoidance mechanisms, emergency stop functionality, and fail-safe systems to prevent hazardous situations.

5.3 Security Requirements

To protect the Fire Extinguisher Robot and its data, security requirements should be addressed. This may involve implementing authentication and access control measures to prevent unauthorized access to the robot's controls and camera footage. Encryption techniques may be employed to secure communication between the robot and external devices.

5.4 Software Quality Attributes

The software quality attributes of the Fire Extinguisher Robot should be considered to ensure a robust and reliable system. This includes requirements related to the code quality, maintainability, scalability, and reliability of the software. Testing and validation processes should be incorporated to verify the functionality and performance of the software components.

5.5 Business Rules

Business rules define the operational guidelines and constraints for the Fire Extinguisher Robot project. These rules may include operational protocols, compliance with industry standards, and any specific regulations or guidelines governing fire safety and robotics. Adhering to business rules ensures that the project meets the necessary standards and regulations.

Appendix :

A) Analysis Models

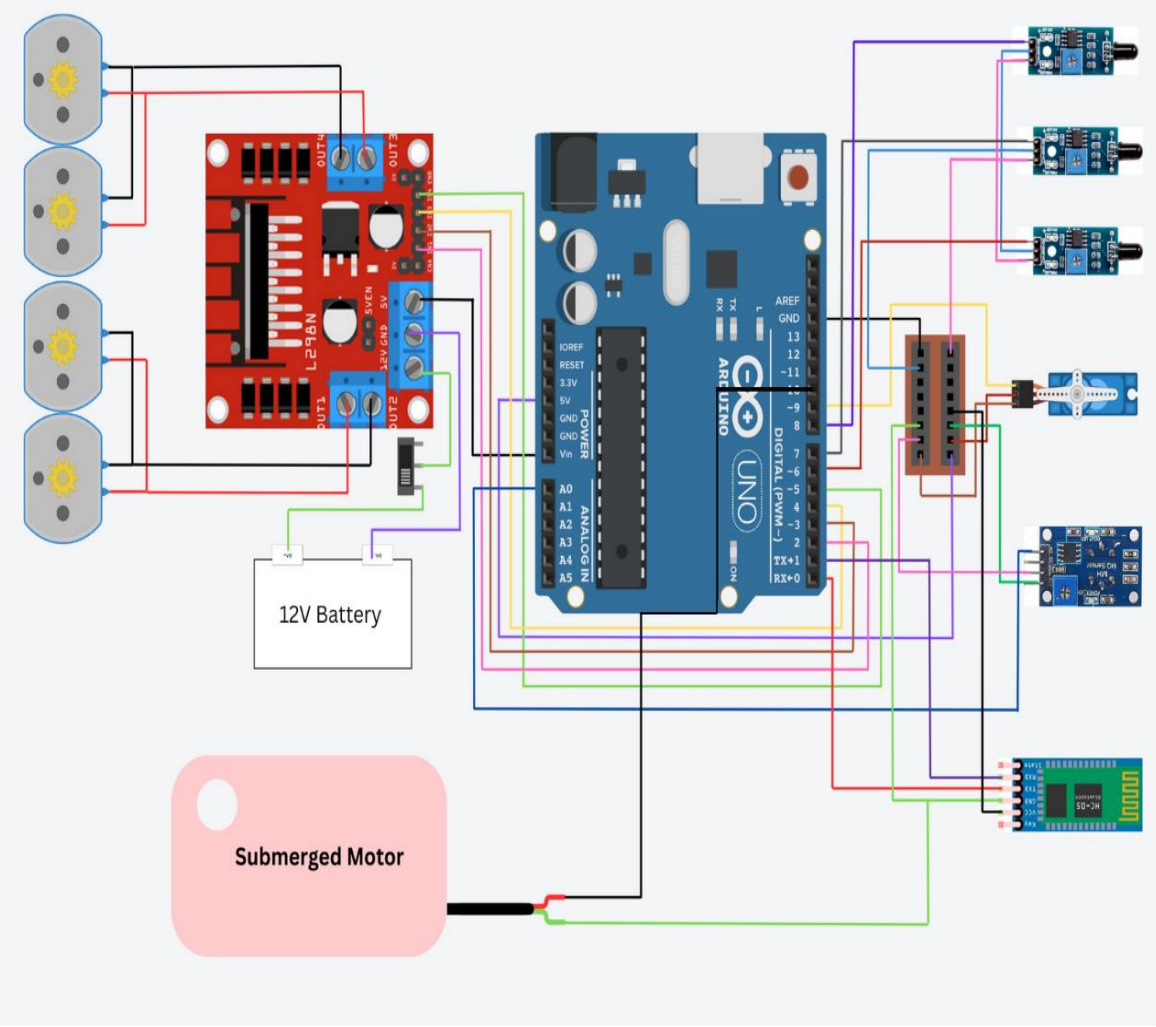

Figure 1 : Circuit Diagram.

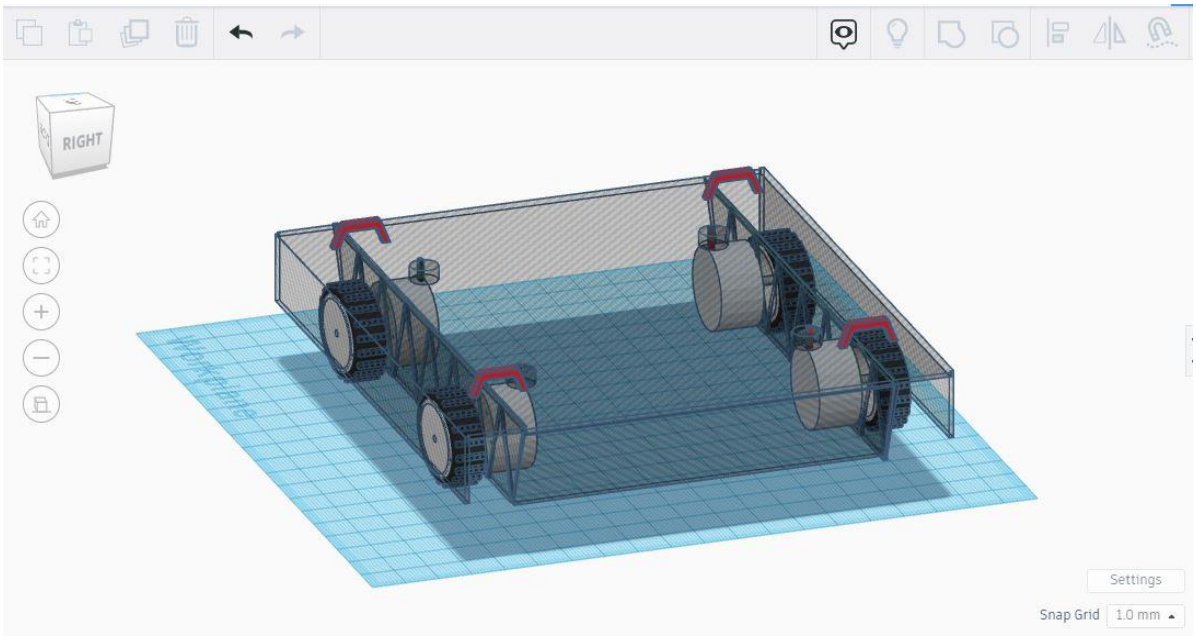

Figure 2: Rover Model Pic-1

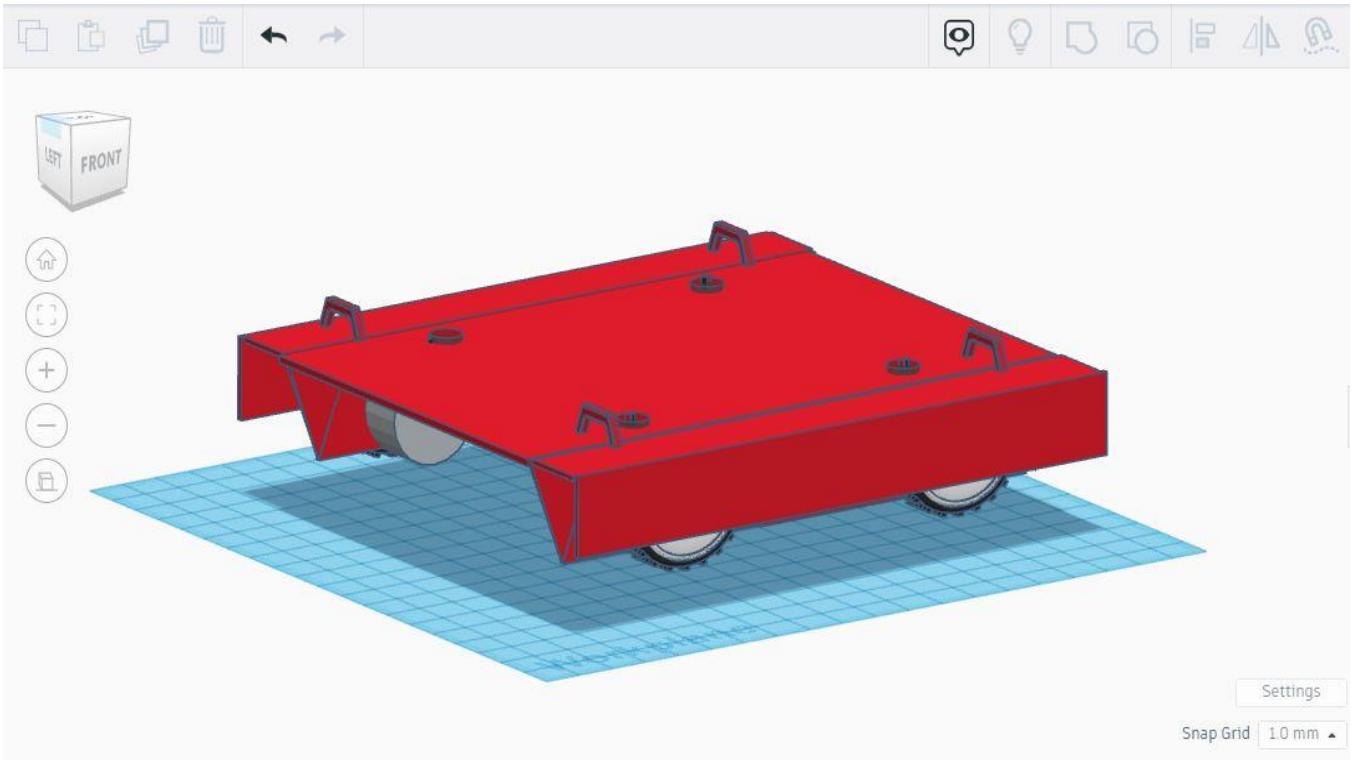

Figure 3: Rover Model Pic-2

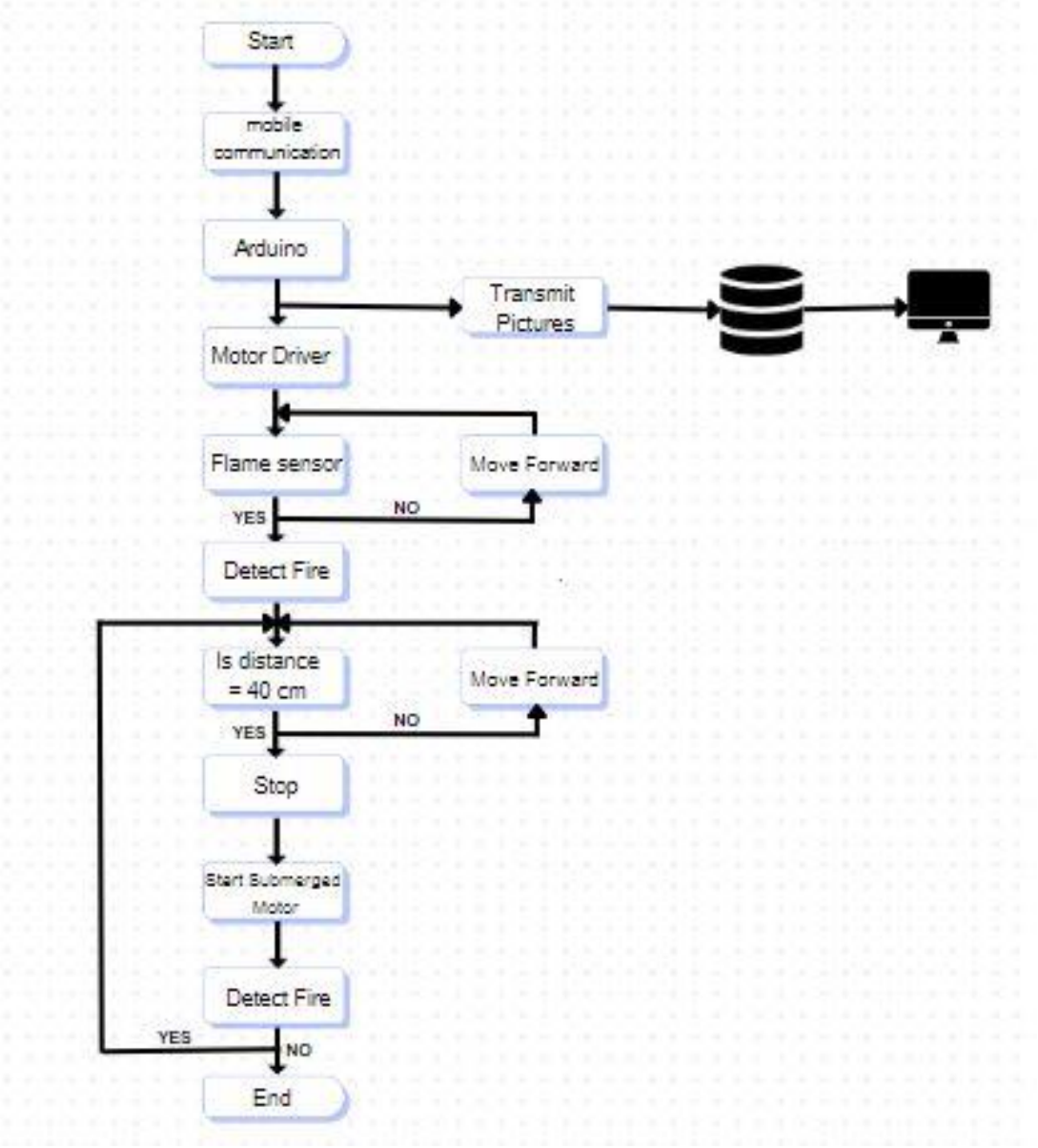

Figure 4 : Working Flowchart